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An Individual System/Organization Cost Model

Volume I

Concept and Application

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ECONOMICS AND COSTING DEPARTMENT
TECHNICAL PAPER RAC-TP-183
Published November 1965

An Individual System/Organization Cost Model

Volume I

Concept and Application

by
John J. Surmeier

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RESEARCH ANALYSIS CORPORATION

McLEAN, VIRGINIA

FOREWORD

This paper is the first of two papers documenting the Individual System/Organization Cost (ISOC) Model and its applications. The ISOC Model is a computer program developed in response to a RAC study need to estimate the relative costs for large numbers of alternative military systems. The large number of alternatives under consideration in the study precluded the use of normal hand computation; consequently the computerized cost model was designed.

The most significant aspect of the ISOC Model is its flexibility in adapting to specific costing problems. It has been used extensively at RAC in a variety of costing applications, examples of which are given in the following list:

(a) In the study "Aviation Requirements for the Combat Structure of the Army" (the ARCSA Study) the ISOC Model was used to estimate the costs on a per-aircraft basis of the entire current Army aircraft inventory. Alternative estimates were proposed showing costs as a function of various support factors computed at each of several levels of organizational aggregation.

(b) In a cost-effectiveness study of a light-observation helicopter (LOH) the ISOC Model was used to measure the cost implications of three competing aircraft and to evaluate the uncertainty in the cost estimates through sensitivity analysis.

(c) In the "Surveillance and Target Acquisition Aircraft Study" the ISOC Model was used to determine the cost of various aircraft and sensor configurations in an organizational context.

(d) In a study for the Advanced Tactics Group, US Army Combat Developments Command, the ISOC Model was used to compute costs for many multi-equipment organizations representing different concepts of corps forces.

The emphasis in this document is on basic description of the ISOC Model rather than on cost-estimating methodology, derivation of inputs that can be used in the model, or analysis of the costs computed. A companion paper is Jodie T. Allen's, Vol II of "The Individual System/Organization Cost Model: Computer Program Design and Operation."

The ISOC Model was developed by our Cost Analysis Group under the direction of Arnold Meltsner. In addition to the author, other members of the Cost Analysis Group who were instrumental in the development of this model were Mrs. Jane-Ring Crane and Mrs. Jodie T. Allen.

Robert N. Grosse
Chief, Economics and Costing Division

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ABBREVIATIONS

FOSCOM	Force Structure Cost Model
ISOC	Individual System/Organization Cost
POL	petroleum, oils, and lubricants
TOE	table of organization and equipment

ABSTRACT

The Individual System/Organization Cost (ISOC) Model was devised for the rapid costing of a large number of alternative systems or organizations. The ISOC Model is a flexible IBM 7040 FORTRAN IV computer framework to which a variety of individual system or organization cost models may be adapted for use in cost studies requiring numerous calculations that cannot be performed conveniently by hand.

This paper is an introduction to the ISOC Model and is not intended as a precise guide for the operation of the model. An operators' manual "The ISOC Model Operators' Manual" is in preparation and will be published separately.

The basic features of the model and the general procedures for its operation are described. An example is provided on the adaptation of a specific cost model, the Surveillance Aircraft System Cost Model, to the computer framework of the ISOC Model. Fictitious data values for two hypothetical surveillance-aircraft systems illustrate procedures for translating data requirements for a specific cost model into a form usable in the ISOC Model. In actual practice the configuration of the ISOC Model will vary according to the costing problem to which it is applied.

Chapter 1

INTRODUCTION

The Individual System/Organization Cost (ISOC) Model described in this paper is an IBM 7040 FORTRAN IV computer program designed to rapidly calculate the relative costs of large numbers of military systems and organizations. The basic purpose of the model is to provide a flexible computer framework to which any specific individual system or organization cost model may be adapted for use in cost studies where the large number of calculations required cannot be performed conveniently by hand. A cost model that has been "fitted" to the ISOC Model becomes a unique computerized system or organization cost model that may be used for any cost problem requiring its specific design configuration.

The ISOC Model may be used for a variety of cost studies, e.g., cost estimates of current or proposed tables of organization and equipment (TOEs), cost-effectiveness analysis, cost estimates of different mixes of hardware within an organization, or cost-sensitivity analysis of various organizations and systems.

It has been designed for relative ease of operation; the principal operator of the model is the cost analyst, not a computer programmer, and little if any knowledge of the IBM FORTRAN IV programming language is required.

Because of the speed and timesaving features of the computer program a larger number of major cost assumptions may be tested for sensitivity than would be feasible if these computations were performed by hand.

One of the principal advantages of the ISOC Model is the materiel data storage file or library. Equipment-cost factors for equipment items common to the systems or organizations being compared may be "stored" in a data file for use in successive calculations thereby eliminating the requirement of entering these cost factors as new inputs for each alternative to be costed. Once such cost factors as maintenance float and combat consumption for each equipment item have been entered in the library the analyst need only enter as new inputs the initial allowances for each materiel item to be costed, and subroutines will then multiply these initial allowances by their respective cost factors (the materiel data library is discussed in the section "General Characteristics of the ISOC Model").

It must be remembered, however, that the model merely serves to simplify and accelerate the process by which the analyst may discover the implications of his cost estimates. In cost analysis the analyst, not the computer model, plays the dominant role. The analyst must design the specific individual system or organization cost model, i.e., he decides what factors are relevant to the cost

analysis problem and what the interrelations between these factors are to be in his model. He must also decide the numerical values of the input variables fed into the ISOC Model. Finally it is the cost analyst who inspects, analyzes, and interprets the results that are the outputs of the model.

Chapter 2 presents a general discussion of the basic characteristics of cost models utilized in the military decision-making process. The principal features of the ISOC Model are described in Chap. 3.

Chapter 4 describes a specific cost model, the Surveillance Aircraft System Cost Model, and is used as an example throughout Chap. 5 to demonstrate the procedures for translating a specific cost model into a form usable in the ISOC Model computer framework. It should be noted that the examples presented in Chaps. 4 and 5 are for illustrative purposes only and are not intended to be restrictive or to represent the only procedures permitted in using the ISOC Model. The most useful aspect of this model is its flexibility in adapting to individual costing problems, and in actual use the procedures followed and data inputs developed will be determined by the characteristics of the specific problem to which the model is applied.

Appendix A contains examples of worksheets that may be used for the collection and organization of data inputs prior to their posting on the input sheets described in Chap. 5. The hypothetical data used to illustrate the ISOC Model are presented in these worksheets.

Although considerable detail is covered in this paper on the features and procedures for use of the model, the paper is intended to serve as an introduction to the ISOC Model and not as a precise guide for its operation. An operators' manual that will provide specific instructions for the operation of the model is now in preparation and will be published separately.

Chapter 2

CONCEPTS OF THE DESIGN AND USE OF COST MODELS

This chapter presents a brief description of the basic characteristics of cost models utilized in the military decision-making process. This review of the concepts of the design and use of individual system or organization cost models discusses the requirements for using a cost model, the general characteristics of a cost model, and the use of cost models for cost-sensitivity analysis.

REQUIREMENTS FOR USING A COST MODEL

One of the major functions of a cost analyst is to provide estimates of the comparative or relative costs of military systems or organizations. In order to cost any system or organization, two steps are involved: (a) the specification of what is to be costed, and (b) the application of cost factors and estimating relations to these physical resources. In comparing one system or organization with another, consistency in the handling of similar resource items is of paramount importance. With the use of cost models there is a better chance that consistency in method will be followed in making comparisons.

A cost model can be defined as any generalized framework, normally involving quantitative techniques, used to estimate the relative costs of competing systems or organizations. A cost model usually attempts to simplify the real world so that a cost analyst may analyze those resource areas of systems or or anizations that are critical to the planning process.

Cost analysis is much more than an estimate of the principal materiel item or items within a system or organization. These equipment items should be considered in the context of a complete system or organization. The use of an organizational framework permits costs other than those of the major equipment items, such as costs related to personnel, operations, and maintenance, to be more easily taken into consideration. When comparing alternative systems or organizations it is therefore necessary to estimate the cost of the complete system or organization. This includes all directly related support costs extending over the entire period from the beginning of its development to activation into the force structure and on through its subsequent operation in the active inventory.

The difference between a military system and a military organization is defined in the "Dictionary of United States Army Terms."*

*Dept of Army, Hq, "Dictionary of United States Army Terms," AR 320-5, Jan 61.

Organization - 1. Any military unit; specifically, a larger command composed of two or more smaller units. In this meaning a military element of a command is an organization in relation to its components and a unit in relation to higher commands. 2. The definite structure of a military element prescribed by a competent authority such as a table of organization.

System - An integrated relationship of components aligned to establish proper functional continuity towards the successful performance of a defined task or tasks.

Both systems and organizations are designed to perform a number of specific military tasks or missions. In this paper a military system is considered as being centered around a principal equipment item. For example, the HAWK missile system is organized around a ground-to-air HAWK missile. In contrast a military organization, although possessing many major equipment items, is not oriented toward any one hardware item. For example, the infantry division is considered an organization rather than a system.

GENERAL CHARACTERISTICS OF A COST MODEL

Usually a cost model has the following general characteristics:

(a) The total resource implications of the systems or organizations to be costed are divided into three major cost categories that portray their time-phased "cradle-to-grave" life cycle:

Research and development costs. All those costs associated with the development of a system or organization up to the point where it is ready for introduction into the active inventory.

Initial investment costs. One-time or initial outlays required beyond the development phase to introduce a new capability into operational use.

Annual operating costs. Recurring costs required to maintain and operate a system or organization throughout its projected life in operational use.

(b) Each of these major cost categories is composed of other sets of categories constructed to preclude the omission of significant cost elements.

(c) The relation of each element and category is spelled out quantitatively.

(d) The cost model is designed in such a way as to assist in the analysis of those cost elements that have the greatest impact on the total cost of a system or organization.

(e) The cost model in its final form usually is composed of a set of equations that give in quantitative terms the type of cost information desired.

In the planning context there are essentially two major types of cost models utilized in military cost analysis: (a) individual system or organization cost models in which each system or organization is costed without consideration of its interaction with the other systems or organizations within the total force structure and (b) total force-structure cost models in which the individual system or organization is costed in the context of the total force structure.

The Department of the Army's Force Structure Cost Model (FOSCOM) is an example of the second type of cost model. Total force-structure cost models portray the real world with a greater degree of accuracy and are better predictive devices for changes in force structure than are individual system or organization cost models. However, when quick comparisons of similar systems or organizations are required, an individual system or organization cost model will permit initial analysis.

There is no single individual system or organization cost model. The type of cost model that the analyst designs will depend on the kinds of questions to be asked of the cost model and the data inputs available. Different types of problems may require different cost models. For example, if the purpose of the cost model is to provide "uninterpreted costs" of present TOEs, then the output format may be less detailed than that of a cost model used in a cost-effectiveness study, where changes in the configuration of the alternatives are to be analyzed. The cost model should be tailored to fit the questions asked and the data available.

USE OF COST MODELS FOR COST-SENSITIVITY ANALYSIS

In comparing costs of alternative systems or organizations, it is important to determine whether the relative costs are really independent of major assumptions or are in fact quite sensitive to them. For example, would it make a significant difference in the relative costs of such competing organizations as an infantry division compared with an airborne division, if one looked at 3 years of peacetime operations as compared to 5 or 9? Would the results be distorted if a high-flying-hour program were used instead of a low one? For a further discussion on cost-sensitivity analysis the reader is referred to Novick.*

Generally the relative change in the ratio of operating to investment costs for the different alternatives would determine the answer. If operating costs relative to investment costs were higher for alternative 1 than for alternative 2, it is reasonable to assume that, as the years of operation increase, alternative 1 will be relatively more expensive than alternative 2. Similarly, if maintenance cost per flying hour were higher for a helicopter than for a fixed-wing aircraft, the helicopter would be relatively more expensive under a high-flying-hour program than a low one. In addition, as the size and complexity of the aircraft are increased, maintenance cost per flying hour will also increase.

In cost-sensitivity analysis the given configuration of a system or organization is first costed, using standard cost-analysis methodology. Then the configuration is perturbed by varying a number of parameters, usually one at a time, and the cost of the system or organization is reestimated for each variation. Finally the resulting costs for each of the alternatives are tested for sensitivity.

*Novick, D., "System and Total Force Cost Analysis," RAND Corp., RM-2995-PR, Apr 61, p 95.

Chapter 3

THE ISOC MODEL

The ISOC Model is an IBM 7040 FORTRAN IV programmed master framework to which any number of specific individual system or organization cost models may be adapted. Both the questions to be answered and the cost information available to the analyst will determine the specific structure of the model. Although the ISOC Model is a computer program, little if any knowledge of the FORTRAN programming language is required by a cost analyst to operate it.

The basic features and uses of the model are described in this chapter.

REQUIREMENTS FOR USING THE ISOC MODEL

Individual system or organization cost models are usually computed by hand. Only when the number of alternatives to be costed becomes too large to be handled manually does a computerized cost model become economically feasible. The break-even point between using hand calculations or an electronic computer depends on such factors as (a) number of alternatives to be costed, (b) complexity of the formulas used in estimating the costs, (c) number of man-hours in terms of dollars required to cost an alternative manually, (d) computer time in terms of dollars for costing the alternatives, and (e) man-hours in terms of dollars required to enter the data into the computer.

By using a computerized cost model it is possible to achieve several distinct advantages over manual calculations: (a) greater speed in costing alternatives, (b) better computational accuracy, (c) better chance of testing major assumptions, and (d) better documentation of the results.

The ISOC Model is a computer framework to which any number of different individual system or organization cost models may be applied. Once a specific cost model has been fitted into the ISOC Model, it becomes a unique individual system or organization computerized cost model that then may be utilized for any cost-analysis problem requiring its specific design configuration.

For example, the ISOC Model may be used for studies involving (a) cost estimates of current or proposed TOEs, (b) cost-effectiveness analysis, (c) cost estimates of different mixes of hardware within an organization, and (d) cost-sensitivity analysis of various organizations and systems. Again, the specific cost-analysis problem will determine whether the individual system

or organization cost model should be adapted to the computerized ISOC Model or should be calculated by hand.

GENERAL CHARACTERISTICS OF THE ISOC MODEL

Principles of Design

The design of a cost model is dependent on (a) the data inputs available on costs and quantities of physical resources and (b) the output in terms of cost categories desired for a specific study. On the basis of the input and output configuration the mathematical equations are formulated that then become the model.

A skeletal framework of the cost categories is initially formulated on the basis of a preliminary knowledge of the cost inputs. As the data inputs are developed with continuing investigation the cost categories are adjusted accordingly to correspond to the input definition. When a relatively firm position has been taken on the data inputs and correspondingly on the cost categories the equations are written. This step-by-step progression in the development of the cost-model framework will be guided throughout by the overall objectives and requirements of the study for which the cost model is intended.

Finally, the adaptation of the specific cost model to the computer framework of the ISOC Model results in a unique individual system or organization computerized cost model that can then be used for any cost analysis problem requiring its specific design.

Speed of Computations

The ISOC Model is a relatively inexpensive computer program designed for relative ease of operation. The model requires 6 min of computer time to calculate the costs for 100 alternative systems or organizations, using an "average-sized" cost model. (An average-sized cost model is defined in this paper as one containing 75 cost elements, 200 data inputs, and 100 other specified equipment items.) Normally, the time required to calculate the cost of one alternative would be less than 5 sec. In contrast the time required to calculate the cost of the same alternative by hand would be approximately 4 hr.

The time required by the cost analyst to prepare the IBM data input sheets for the model is more difficult to estimate. Two major factors will determine the time required to prepare these input sheets: (a) the extent to which a specific cost model already has been fitted into the ISOC Model and (b) the complexity of design of the specific cost model to be applied to the ISOC Model.

If the ISOC Model has already been adapted to a specific cost model, less than 15 min will normally be required to prepare three specially designed data-input sheets necessary for costing the alternative.

The most time-consuming operation performed by the analyst is the adaptation of the ISOC Model to a new specific cost model, since the specific cost model must be constructed and fitted into the ISOC Model. Approximately 8 to 24 hr will be required to prepare the data-input sheets and check the ISOC Model program.

An example of fitting a specified individual system cost model into the ISOC Model is presented in Chap. 5.

Materiel Data Library

The ISOC Model provides a library of cost factors for equipment items common to more than one organization. For example, the M14 rifle, the AN/VRC-12 radio sets, and 2½-ton trucks can usually be found in most Army combat organizations. Although the initial allowances for these materiel items vary with the particular organization or system, the cost factors related to each materiel item usually remain the same.

The library simplifies the inputs required in costing a large number of organizations and systems, since the cost factors need not be entered as inputs each time initial allowances are specified for an organization or system. This feature is particularly useful in calculating the costs of Army organizations that have many of these common materiel requirements. The library may supply the following information for a maximum of 300 individual materiel items: (a) average unit costs, (b) maintenance-float factors, (c) replacement/consumption factors, and (d) combat-consumption factors.

Once the factors for these common equipment items have been entered into the library, the analyst need only specify the initial allowance for each materiel item to be costed. Subprograms in the ISOC Model then will multiply these initial materiel allowances by their respective cost factors. One or more of these subprograms may be used to calculate (a) initial allowances plus maintenance float, (b) initial stocks, (c) initial allowances plus maintenance float plus stocks, and/or (d) replacement/consumption for the chosen group of items. Any of these computed quantities may be used as a term in any cost-category equation.

Output Format

The output format of the ISOC Model contains the following information:

(a) List of the major data inputs to the model for each system or organization costed.

(b) List of the initial allowance specifications for the "other specified equipment" for each system or organization costed.

(c) Total costs for each alternative system or organization subdivided into major cost categories consisting of research and development, initial investment, and annual operating costs. Detailed costs printed on the output format will depend on the cost categories and cost elements defined within these three major cost categories for a specific cost problem.

(d) Other selected data to be printed out with each alternative costed.

Sample output formats displaying cost categories and sensitivity parameters for two different types of cost studies are illustrated in Figs. 1 and 2. Figure 1 provides an example of an output format for a sample TOE unit; Fig. 2, for an organization incremental to an existing force structure. All the examples given are hypothetical and are presented for illustrative purposes only.

An example of a complete output format containing all the information on output format is presented in Chap. 5, "Sample of Output Format of the ISOC Model for Surveillance Aircraft System B."

```
04/20/65                                                                          PAGE    2
                                INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

DIVISION ARTILLERY    TOE 6-300E   UNIT STRENGTH 2416                           ALTERNATIVE
   HQ + HQ BTRY         TOE 6-302E   UNIT STRENGTH  205
   3 FA BNS 105 SP      TOE 6-345E   UNIT STRENGTH 1374
   FA BN 155MM/8INCH    TOE 6-355E   UNIT STRENGTH  592
   FA BN HONEST JOHN    TOE 6-175E   UNIT STRENGTH  245
   THE FACTORS USED IN THE EXAMPLE ARE FICTITIOUS
   ONE YEAR OF OPERATING COSTS

          COST CATEGORIES                                    DOLLARS IN TENS OF THOUSANDS

RESEARCH AND DEVELOPMENT
TOTAL RESEARCH AND DEVELOPMENT                                                  -----    0.

INVESTMENT
        INITIAL ISSUE
                PEMA EQUIPMENT
                                                              ----- 2554.30
                O MA EQUIPMENT
                                                              -----  137.20
                                                                      ----- 2691.50
        MAINTENANCE FLOAT EQUIPMENT
                                                                      -----  181.30
        COMBAT CONSUMPTION EQUIPMENT
                                                                      -----  116.30
        AMMUNITION BASIC LOAD
                                                                      -----  345.60
        FUEL AND SUPPLIES
                                                                      -----   47.00
        SPECIALIST TRAINING
                                                                      -----  222.40
TOTAL INVESTMENT                                                                ----- 3604.10
```

Fig. 1—Example of Output Format for Sample TOE Unit

04/20/65 PAGE 3

COST CATEGORIES	DOLLARS IN TENS OF THOUSANDS	
ANNUAL OPERATING		
MILITARY PERSONNEL	----- 964.50	
SPECIAL TRAINING	----- 44.50	
UNIT DIRECT OPERATIONS	----- 357.60	
DEPOT MAINTENANCE	----- 234.60	
EQUIPMENT REPLACEMENT	----- 64.30	
AMMUNITION AND MISSILES	----- 203.60	
SUPPORT AND OVERHEAD	----- 246.40	
TOTAL ANNUAL OPERATING		----- 2115.50
TOTAL RESEARCH AND DEVELOPMENT, INITIAL INVESTMENT, ANNUAL OPERATING		5719.60

SENSITIVITY PARAMETERS

YEARS OF OPERATION 1

Fig. 1 (continued)

```
04/29/65                                                                                             PAGE   2
                                        INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL
                                                                                               ALTERNATIVE   1
HYPOTHETICAL ORGANIZATION
   ORGANIZATION INCREMENTAL TO PRESENT FORCE STRUCTURE
   ORGANIZATIONAL STRENGTH 12345
   THE COSTS PRESENTED BELOW ARE FOR ILLUSTRATIVE PURPOSES ONLY
   THE FACTORS USED IN THE EXAMPLE ARE FICTITIOUS

          COST CATEGORIES                                      DOLLARS IN MILLIONS


RESEARCH AND DEVELOPMENT
TOTAL RESEARCH AND DEVELOPMENT                                                            -----   0.11


INVESTMENT
        MILITARY CONSTRUCTION
                ARMY                                                        -----   0.11

                ARMY NATIONAL GUARD                                         -----   0.

                ARMY RESERVE                                                -----   0.
                                                                                    -----   0.11

        PEMA                                                                        -----  111.00
TOTAL INVESTMENT                                                                            -----  111.11
```

Fig. 2—Example of Output Format for Hypothetical Organization

COST CATEGORIES		DOLLARS IN MILLIONS		
ANNUAL OPERATIONS				
PROM OF RIFLE PRAC			0.	
MILITARY PERSONNEL				
ARMY		0.55		
ARMY RESERVE		0.		
ARMY NAT GUARD		0.		
			0.55	
OPERATIONS AND MAINTENANCE				
ARMY NAT GUARD		0.		
OPERATING FORCES	-BP2000-	55.55		
TRAINING ACTIVITIES	-BP2100-	0.55		
CENTRAL SUPPLY	-BP2200-	0.55		
MAJOR OVERHAUL	-BP2300-	0.55		
MEDICAL ACTIVITIES	-BP2400-	0.55		
ARMY WIDE ACTIVITIES	-BP2500-	0.55		
INTELLIGENCE	-BP2800-	0.		
COMM. AND PICT.	-BP2900-	0.		
			58.32	
TOTAL ANNUAL OPERATIONS				58.88
TOTAL RESEARCH AND DEVELOPMENT, INITIAL INVESTMENT, ANNUAL OPERATING				170.10

SENSITIVITY PARAMETERS

YEARS OF OPERATION	5

Fig. 2 (continued)

USE OF THE ISOC MODEL FOR COST-SENSITIVITY ANALYSIS

The ISOC Model permits a large number of major cost assumptions to be tested for sensitivity. In testing sensitivity through the ISOC Model the analyst is not required to enter a completely new set of data for each alternative to be costed. The model only requires a new set of data for the assumptions being tested; the basic cost data for each system or organization to be costed are entered once and are used to calculate the costs for the "basic" configuration of the system or organization.

For sensitivity analysis the ISOC Model will replace the basic data values with new data values and then will recalculate the costs for the alternative system or organization. These modifications to the basic data represent new alternative cost estimates for that system or configuration. The process is continued until all the sensitivity assumptions have been costed.

Such major data values as inputs that are the same for all organizations or systems to be costed or inputs that are unique to a particular system may be altered for cost-sensitivity analysis.

The analyst may enter certain major assumptions only once for all organizations or systems to be costed. These major assumptions are in the form of activity factors, which are the same for all systems or organizations, as compared with cost or specification factors, which may vary with each system or organization. These major assumptions would include such activity factors as years of operations, flying-hour programs, and months of combat stockage. It is possible to select a maximum of five different years of operations and five other assumptions, each with a maximum of five different activity factors. In the following example the cost analyst selected five different years of operations, three different flying-hour programs, and two different months of combat stockage:

(a) Years of operations: 1, 3, 5, 9, and 11.
(b) Annual peacetime flying-hour programs: 240, 360, and 480.
(c) Months of combat stockage: 2 and 6.

These activity factors are entered only once in the model. With the above data, 30 alternatives will be costed for each system or organization entered in the model calculations ($5 \times 3 \times 2 = 30$ alternatives). Disregarding years of operations, a maximum of 3125 alternatives could be costed for one system or organization using this feature ($5 \times 5 \times 5 \times 5 \times 5 = 3125$). Obviously, in using this input device the analyst must take care in selecting the number of sensitivity assumptions and the number of factors for each assumption.

Other major assumptions that are unique to a particular system, e.g., the cost estimates for an aircraft, may be entered on a data change sheet.

Chapter 4

EXAMPLE OF A SPECIFIC COST MODEL

This chapter presents an example of a specific individual system cost model, the Surveillance Aircraft System Cost Model. This cost model can be used to estimate the relative costs of alternative surveillance aircraft systems. An individual with no more tools than perhaps a slide rule, pencil, and paper could use this model. Using this Surveillance Aircraft System Cost Model and the hypothetical cost data presented in App A, an analyst could calculate 240 alternatives by hand. The other extreme to these simple requirements is described in the following chapter on the use of the ISOC Model, for which a high-speed electronic computer is required. The information in Chap. 4 describes the structure of the system cost model, which is used to illustrate the procedures for adapting a cost model to the ISOC Model computer framework in Chap. 5.

DESIGN OF THE COST MODEL

The cost model described in this section was developed to estimate the relative costs associated with a number of future surveillance aircraft systems. The cost model was designed to compare both Air Force and Army surveillance aircraft systems. The differences between the services in such areas as procurement policies, aircraft-maintenance organization, and logistics policies required that care be taken to maintain consistency in the method of treating similar items of resources in the different systems.

The Surveillance Aircraft System Cost Model discussed in this chapter was originally designed for a specific cost analysis study. Its design was based on two major factors: (a) the specific costing problem and (b) the cost data available.

The Surveillance Aircraft System Cost Model was structured to identify the costs as they occur in the natural life cycle of the systems in terms of (a) research and development, (b) investment, and (c) operating. The cost categories and their cost elements for the surveillance aircraft study are shown in the accompanying list.

Cost Categories

Research and Development. In the Surveillance Aircraft System Cost Model two cost elements were used in the estimation of research and development: (a) for the aircraft and (b) for the surveillance packages. The costs of research and development were estimated outside the cost model and processed in the model

as "thruputs," i.e., input values on which no machine calculations are performed, hence values are unchanged from input to output.

Initial Investment. Initial investment for the surveillance aircraft system was subdivided into four main cost elements: personnel, installations, equipment, and initial stocks.

"Personnel." This cost category represents the initial cost of training and moving the additional personnel required by the introduction of the new surveillance system. The categories for personnel were further subdivided into initial training and initial travel.

Cost Categories and Elements
for the
Surveillance Aircraft System Cost Model

1.0 Research and Development	3.0 Annual Operating
1.1 Aircraft	3.1 Personnel
1.2 Surveillance	3.1.1 Training
	3.1.1.1 Pilots
2.0 Initial Investment	3.1.1.2 Officer, Other
2.1 Personnel	3.1.1.3 Enlisted
2.1.1 Training	3.1.2 Pay and Allowances
2.1.1.1 New Pilots	3.1.2.1 Officer, Rated
2.1.1.2 Transitional Pilots	3.1.2.2 Officer, Nonrated
2.1.1.3 Officer, Other	3.1.2.3 Enlisted
2.1.1.4 Enlisted	3.1.2.4 Civilian
2.1.2 Travel	3.1.3 Travel
2.2 Installations	3.2 Equipment
2.3 Equipment	3.2.1 Aircraft Attrition
2.3.1 Aircraft	3.2.2 Other Replacement/Consumption
2.3.2 Ground Support	3.3 Maintenance
2.3.3 Other Specified	3.3.1 Facilities
2.3.4 Organizational	3.3.2 Aircraft
2.4 Initial Stocks	3.3.3 Other Equipment
2.4.1 Aircraft Spares	3.4 POL
2.4.2 Aircraft POL	3.5 Services and Other
2.4.3 Other Specified	

"Initial training" of personnel includes the resources required to bring each man up to the level of skill required for his occupation in the new system or organization. Initial training represents the incremental resources required for the introduction of the system into the force structure. The availability of fully trained personnel as well as the number of personnel requiring complete or transitional training are taken into consideration in determining the resources required. After the personnel required have been specified, the factors representing the per-man training costs are applied to each of their respective occupational groups to generate the initial training costs for the system. Four types of personnel were used in specifying the requirements for initial training: new pilots, transitional pilots, other officers, and enlisted personnel.

"Initial travel" includes the resources expended in transporting military personnel to their first assigned duty station. Initial travel costs for the surveillance system were computed by the application of travel-cost factors to the totals of specified officers and enlisted personnel.

"Installations." This cost element represents the resource implications of providing any additional facilities required for the introduction of a new system.

Installation costs were treated as "thruputs" in the Surveillance Aircraft System Cost Model. In other words the cost estimates for installations were made outside the cost model and no functional relation within the cost model was used to estimate installation costs.

"Equipment." This cost category includes the initial cost for the operational equipment that the system will have on hand, plus the stocks required to provide a replacement for items that need major overhaul and maintenance. The operational equipment assigned to the organizations is designated "initial allowances" by the Army and "unit equipment" by the Air Force. The stockage is termed "maintenance float" in the Army and "command support" in the Air Force. Two other requirements for equipment, combat consumption and replacement/consumption, are accounted for under the cost categories "initial stocks" and "annual equipment replacement/consumption" respectively.

In any cost analysis study, all costs are not individually developed. Several levels of detail are always considered, and the emphasis of the study determines which costs will be estimated implicitly and which ones will be included in more highly aggregated cost factors in which individual detail is obscured.

For analytical purposes the costs for aircraft and ground-support surveillance equipment were separated from the other materiel costs. Four cost elements were used to estimate equipment: aircraft, ground support, other specified equipment, and organizational equipment.

The costs for the first three cost elements were computed by multiplying initial allowances plus maintenance-float stockage by the average unit cost of the equipment.

The fourth cost element, organizational equipment, represents the residual equipment not directly specified for the system. The cost of this residual equipment was approximated for a surveillance aircraft system by a per-militaryman cost factor.

"Initial Stocks." This category includes those supplies that are carried by combat and support organizations for the effective and continuing operations of the unit. In the study of the surveillance aircraft systems, initial stocks included aircraft spares, aircraft petroleum, oils, and lubricants (POL), and other specified stocks.

"Aircraft spares" represents the extra equipment, accessories, or the like that are held in reserve for use when needed. This cost element was estimated by applying a spares factor for the aircraft to the total cost of the aircraft in the system.

"Aircraft POL stocks" represents the initial POL stockage required when introducing a new system into the force structure. A specified number of months' proportion of annual POL consumption is used in estimating initial POL cost. (Annual POL consumption is estimated as the product of POL cost per flying hour per aircraft, the flying-hour program per year, and the initial allowances of the aircraft.)

"Other specified stocks" represents the materiel stocks procured for use during the early phases of combat while production is being expanded. Procurement of combat-consumption stockage could be authorized for such items as trucks, rifles, and radios. The cost estimates for this stockage represent

the summation of the various equipment items authorized by logistics guidance. For those authorized items the cost of combat consumption stocks is generated as the product of four factors: initial allowances, stockage factor (percentage per month), months of supply authorized by logistics guidance, and the cost of the equipment item.

Annual Operating. Annual operating represents those recurring costs required to maintain and operate the capability of the system throughout its projected life in operational use.

Five cost categories were used in estimating the annual operating costs of the alternative surveillance systems: personnel, equipment, maintenance, POL, and services and other.

"Personnel." Annual operating costs for personnel were divided into three cost categories: annual training, pay and allowances, and annual travel.

"Annual training" represents the cost of training replacements for personnel leaving the military service as a result of discharge, return to inactive status, or retirement. The annual training costs for personnel represents the summation of annual training costs for pilots, other officers, and enlisted men. For each of these specification categories, annual training costs were estimated by multiplying the total number of personnel in each category by an annual turnover rate to arrive at the number of additional personnel required per year to maintain the personnel level within the system. The number of additional personnel multiplied by an estimated initial training cost generated the annual training cost for that personnel type.

"Pay and allowances" includes the annual costs of such items as basic pay, quarters allowance, and maintenance of clothing, associated with personnel in each system. In the Surveillance Aircraft System Cost Model, pay and allowances were calculated for four types of personnel: flight-rated officers, nonrated officers, enlisted men, and civilian personnel. Costs of annual pay and allowances were computed by multiplying the specified number of each personnel type by an applicable pay and allowance factor. After the annual pay and allowances costs for each personnel type were estimated, these costs were summed to arrive at the total annual pay and allowance costs for the system.

"Annual travel" represents the costs incurred in transporting the replacement personnel and their dependents to the assigned duty station. Annual travel costs for the surveillance-aircraft systems were calculated by applying appropriate initial travel-cost factors to the number of additional personnel required annually to replace personnel who leave the military service.

"Equipment." This cost category includes the resource implications for peacetime attrition, training, and other annual consumption of materiel. This additional equipment is required so that the authorized equipment levels will not be depleted over time. Equipment was divided into the following subcategories: aircraft attrition and other replacement/consumption.

"Aircraft attrition" represents the costs for the number of aircraft attrited per year during peacetime operations. Attrition aircraft is estimated as the product of three quantities: the number of aircraft attrited per 100,000 flying hours, annual flying-hour program per aircraft, and the number of initial allowance (unit equipment) aircraft in the system. Attrition aircraft required per year is then multiplied by the average unit cost of the aircraft to estimate the cost.

"Other replacement/consumption" includes the estimated costs for annual replacement or consumption of equipment other than aircraft in the system. Yearly replacement/consumption costs for an equipment item are computed as the product of an annual replacement/consumption factor, the initial allowance for the equipment item, and the average unit cost of the equipment.

"Maintenance." This category represents the annual costs required for maintenance support of the units' equipment and facilities. Maintenance costs were divided into three categories: maintenance of facilities, aircraft maintenance, and other equipment maintenance.

"Maintenance of facilities" includes the materials and contractual services required for maintenance of the installations. Military personnel associated with maintenance of facilities are not included in this cost estimate but are costed under the category "pay and allowances." Maintenance of facilities was treated as a "thruput" in the Surveillance Aircraft System Cost Model.

"Aircraft maintenance" represents the annual cost of materiel and depot labor required for maintenance of the aircraft within the surveillance-aircraft system. The maintenance of aircraft would include both base and depot for the Air Force, and first through fifth echelon for the Army. Pay and allowances costs for maintenance other than depot (fourth and fifth echelon) would be included in the cost category "pay and allowances." This cost category was estimated as the product of the initial allowance of aircraft, the annual flying-hour program per aircraft, and a maintenance cost per flying hour.

"Other equipment maintenance" represents the annual cost of materiel and depot labor required to maintain the other equipment in a system. This cost category was estimated by multiplying a per-man maintenance factor by the total number of military personnel in the system.

"POL." This cost category represents the annual expenditures for fuels and lubricants required for the aircraft in the surveillance system. The estimate for POL costs was obtained as the product of the initial allowance of aircraft, the annual flying hours per aircraft, and the cost of POL per flying hour.

"Services and other." This cost category represents those annual operating and maintenance costs not included in any other category. This encompasses such costs as contractual services, miscellaneous fuels, and locally processed items. The "services and other" cost category was calculated by multiplying the total number of military personnel by a per-man cost factor.

Mathematical Notations

The English statements describing each element and category in a cost model usually are translated into the more convenient mathematical form, e.g., the statement "The cost of training new pilots in a system is equal to the product of the number of new pilots required and the training cost for each new pilot," mathematically becomes:

$$A = B \times C$$

where A = cost of training the new pilots in a system
B = number of new pilots required
C = training cost for each new pilot

In most cost models, mnemonic names are chosen for the algebraic symbols. (Mnemonic names represent any scheme or device used as an aid in

TABLE 1

Mathematical Statements for the Surveillance Aircraft System Cost Model

Cost category and element		Symbol
1.0 Research and development	=	(1.1) + (1.2)
1.1 Aircraft	=	RDAC
1.2 Surveillance	=	RDS
2.0 Initial investment	=	(2.1) + (2.2) + (2.3) + (2.4)
2.1 Personnel	=	(2.1.1) + (2.1.2)
2.1.1 Training	=	(2.1.1.1) + (2.1.1.2) + (2.1.1.3) + (2.1.1.4)
2.1.1.1 New pilots	=	PPN × TPN
2.1.1.2 Transitional pilots	=	PPT × TPT
2.1.1.3 Officer, other	=	POO × TOO
2.1.1.4 Enlisted	=	PE × TE
2.1.2 Travel	=	(TVO × PO) + (TVE × PE)
2.2 Installations	=	FACI
2.3 Equipment	=	(2.3.1) + (2.3.2) + (2.3.3) + (2.3.4)
2.3.1 Aircraft	=	ACT × CAC
2.3.2 Ground support	=	SG × CSG
2.3.3 Other specified	=	$\Sigma_{i=1}^{N} IA_i (1 + MF_i) C_i$
2.3.4 Organizational	=	PM × COE
2.4 Initial stocks	=	(2.4.1) + (2.4.2) + (2.4.3)
2.4.1 Aircraft spares	=	SP × ACT × CAC
2.4.2 Aircraft POL	=	SM/12.0 × POL × FH × ACI
2.4.3 Other specified	=	$\Sigma_{i=1}^{N} IA_i \times CC_i \times LOC \times C_i$
3.0 Annual operating	=	(3.1) + (3.2) + (3.3) + (3.4) + (3.5)
3.1 Personnel	=	(3.1.1) + (3.1.2) + (3.1.3)
3.1.1 Training	=	(3.1.1.1) + (3.1.1.2) + (3.1.1.3) + (3.1.1.4)
3.1.1.1 Pilots	=	YRS × TPN × PP × TORP
3.1.1.2 Officer, other	=	YRS × TOO × POO × TORO
3.1.1.3 Enlisted	=	YRS × TE × PE × TORE
3.1.2 Pay and allowances	=	(3.1.2.1) + (3.1.2.2) + (3.1.2.3) + (3.1.2.4)
3.1.2.1 Officer, rated	=	YRS × PR × PAR
3.1.2.2 Officer, nonrated	=	YRS × PNR × PANR
3.1.2.3 Enlisted	=	YRS × PE × PAE
3.1.2.4 Civilian	=	YRS × PC × PAC
3.1.3 Travel	=	YRS [TVO × (PP × TORP + POO × TORO) + TVE × PE × TORE]
3.2 Equipment	=	(3.2.1) + (3.2.2)
3.2.1 Aircraft attrition	=	$YRS\ (ACI \times FH \times \frac{RCAC}{100{,}000}\ \text{round integer})\ CAC$
3.2.2 Other replacement/consumption	=	$\Sigma_{i=1}^{N} YRS\ [(IA_i \times RC_i)\ C_i]$
3.3 Maintenance	=	(3.3.1) + (3.3.2) + (3.3.3)
3.3.1 Facilities	=	YRS × FACM
3.3.2 Aircraft	=	YRS × ACI × FH × CMFH
3.3.3 Other equipment	=	YRS × PM × CMU
3.4 POL	=	YRS × ACI × FH × POL
3.5 Services and other	=	YRS × PM × CO

TABLE 2

Variable Data Names for the Surveillance Aircraft System Cost Model

Data name	Identification
	Major Names
ACI	= Initial allowances—aircraft
ACT	= Initial allowances plus maintenance float-aircraft
CAC	= Average unit cost—aircraft
CMU	= Maintenance—cost per military personnel
CMFH	= Maintenance—cost per flying hour
CO	= Services and other
COE	= Cost—organizational equipment cost per military personnel
CSG	= Average unit cost—sensor
FACI	= Initial installations
FACM	= Maintenance of facilities
FH	= Peacetime annual flying hour per aircraft
LOG	= Number of months of logistics guidance
PAC	= Pay and allowances—civilian
PAE	= Pay and allowances—enlisted
PAN	= Pay and allowances—nonrated officers
PAR	= Pay and allowances—rated officers
PC	= Total number of civilian personnel
PE	= Total number of enlisted personnel
PM	= Total number of military personnel
RNR	= Number of nonrated officers
PO	= Total number of officers
POO	= Number of other officers
POL	= POL—cost per flying hour
PP	= Total number of pilots
PPN	= Number of new pilots
PPT	= Number of transitional pilots
PR	= Number of rated officers
RCAC	= Peacetime aircraft attrition per 100,000 flying hours
RDAC	= Research and development—aircraft
RDS	= Research and development—surveillance
SG	= Initial allowances plus maintenance float—sensor
SM	= Months of stockage
SP	= Initial spares factor—aircraft
TE	= Initial training cost—enlisted
TOO	= Initial training cost—other officers
TORE	= Turnover ratio—enlisted
TORO	= Turnover ratio—other officers
TORP	= Turnover ratio—pilots
TPN	= Initial training cost—new pilots
TPT	= Initial training cost—transitional pilots
TVE	= Travel cost—enlisted
TVO	= Travel cost—officers
	Other Specified Equipment Names
CC_i	= Combat consumption factor for the ith equipment item
IA_i	= Initial allowance for the ith equipment item
MF_i	= Maintenance float factor for the ith equipment item
RC_i	= Replacement/consumption factor for the ith equipment item

remembering certain facts.) For example, the mnemonic name for personnel, pilot, new could be PPN, and for training cost per pilot, new the mnemonic name could be TPN. In the Surveillance Aircraft System Cost Model, mnemonic names were used for the data variables, and digit-level indicators were used to replace the English names for the result of each cost computation. These are illustrated in the following example:

2.1.1.1 New pilots = PPN × TPN

where PPN = number of new pilots required
TPN = training cost for each new pilot
2.1.1.1 = cost of training the new pilots in a system

In addition, decimal-level indicators were used to sum the results of the cost calculations to the level of their respective cost categories:

2.0 Initial investment = (2.1) + (2.2) + (2.3) + (2.4)
2.1 Personnel = (2.1.1) + (2.1.2)
2.1.1 Training = (2.1.1.1) + (2.1.1.2) + (2.1.1.3) + (2.1.1.4)
2.1.1.1 New pilots = PPN × TPN

The mathematical statements used in the Surveillance Aircraft System Cost Model, followed by a list of the mnemonic data names and their English translation, are provided in Tables 1 and 2, respectively.

DATA INPUTS

Once the cost model has been designed and the sensitivity parameters established the cost model is ready for operation. All that is lacking in the Surveillance Aircraft System Cost Model is the actual data to be used in place of the data names in the cost-element equations.

Examples of the types of data inputs that may be used in the Surveillance Aircraft System Cost Model are presented in App A for two hypothetical aircraft systems. It should be noted that these data inputs are fictitious and are presented for illustrative purposes only. However, given these simulated data inputs a cost analyst could, if he desired, calculate the cost manually for 240 alternatives (2 aircraft systems × 5 different years of operating × 3 flying-hour programs × 2 combat-consumption stockage policies × 2 aircraft cost estimates × 2 attrition factors = 240 alternatives) or use the ISOC Model discussed in Chap. 5.

SENSITIVITY ANALYSIS

Usually there are numerous assumptions for which sensitivity analysis would be desired. Some possible assumptions that could be tested for each surveillance-aircraft system are

(a) Years of peacetime operating: 3, 5, 7, 9, or 11.
(b) Annual peacetime flying-hour program: 240, 360, or 480.
(c) Months of combat consumption stockage policy: 2 and 6.
(d) Aircraft cost estimate: upper and lower estimate for each aircraft.
(e) Peacetime attrition per 100,000 flying hours: upper and lower estimate for each aircraft.

If a. .ne assumptions shown above were desired for cost analysis of five surveillance-aircraft systems, the costing of 600 alternatives would be required (i.e., 5 × 5 × 3 × 2 × 2 × 2 = 600). It should be noted that the major use of a cost model is for analysis. The mere costing of a large number of alternatives does not provide cost analysis. In fact the data-reduction problem of selecting those alternatives to be analyzed in detail is a major problem. Care must be taken by the cost analyst in selecting the alternatives to be costed.

Chapter 5

EXAMPLE OF THE USE OF THE ISOC MODEL

The costs of the two surveillance aircraft systems discussed in the previous chapter could have been hand-computed using the Surveillance Aircraft System Cost Model. However, if one were to test the sensitivity of the major assumptions defined in the section "Mathematical Notations," a total of 240 alternatives would require costing for the two aircraft systems. For this costing problem the use of the ISOC Model would be desirable.

In this chapter the features of the Surveillance Aircraft System Cost Model and fictitious data values devised for the two hypothetical aircraft systems are used to illustrate the procedures for translating the data for a specific cost model into a form usable in the ISOC Model. Detailed information regarding data format specifications, quantity restrictions, input deck preparation, and program operation will be included in Vol II of this paper now in preparation.

PREPARATION OF INPUT DATA

The input data for the ISOC Model are entered on 10 special preprinted input sheets, which are divided into three sets. Set A contains the data required to cost alternative systems or organizations. Sets B and C relate to the design of the specific cost model when adapted to the ISOC Model configuration. Supplementary information relating to the specific model is also contained in Set B.

The FORTRAN programming language is used only to enter data on the input sheets in Set C.

The input sheets used for the ISOC Model consist of the following:

Sheet	Title
C-1	Preliminary Equations
C-2	Cost-Element Equations
C-3	COMMON Data Sequence
B-1	Cost Category/Element Names
B-2	Selected Data for Printout
B-3	Other Specified Equipment Items
B-4	General Sensitivity Assumptions
A-1	Major Data Inputs
A-2	Initial Allowances of Other Specified Equipment
A-3	Major Data-Change Sheet

Punched cards are prepared from these input sheets, and the data in this form are then used as inputs to the IBM FORTRAN IV ISOC Model computer program.

ADAPTATION TO A SPECIFIC COST MODEL

This section discusses the inputs that must be completed when a new specific individual system or organization cost model is fitted into the ISOC Model. These inputs are required only when modifications or changes to a specific cost model are made for use in the ISOC Model. Approximately 8 hr was required by the cost analyst to translate the information on the Surveillance Aircraft System Cost Model to a form usable in the ISOC Model. These 8 hr included preparation of the input sheets in Sets B and C as well as "debugging" the computer model.

Input Sheet C-1—Preliminary Equations

Input Sheet C-1 is used to enter any equations that are necessary to calculate intermediate values for eventual use in the cost-element equations. Equations to calculate the average unit cost from cost-quantity relationships (i.e., "learning curves") could be entered on this sheet.

For the Surveillance Aircraft System Cost Model it was considered desirable to have the ISOC Model compute the total number of pilots, the total number of officers, and the total number of military personnel instead of calculating the totals manually outside the model. The mathematical statements required to calculate these figures are

$$\begin{aligned} PP &= PPN + PPT \\ P\emptyset &= PP + P\emptyset\emptyset \\ PM &= P\emptyset + PE \end{aligned}$$

where PP = total number of pilots
PPN = number of new pilots
PPT = number of transitional pilots
PØ = total number of officers
PØØ = number of other officers
PM = total number of military personnel
PE = number of enlisted personnel

These preliminary equations coded in FORTRAN IV programming language were entered on Sheet C-1 for the Surveillance Aircraft System Cost Model. Figure 3 shows these three equations as they are entered on the input sheet.

FORTRAN IV programming permits intermediate calculations to be stored for later use in the program. Once a value has been generated in the ISOC Model it can be used in following equations. For example, in the equations shown in Fig. 3, not only are the three FORTRAN statements used in the cost-element equations, but also the total number of pilots (PP) calculated in the first equation is used in the second FORTRAN statement to compute the total number of officers (PO).

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

SHEET C-1

PRELIMINARY EQUATIONS

Name ____________

Date ____________

Page ____________

Cont No (6)	Equation (7–72)	Identification* (76–80)
	PP = PPN + PPT	0200
	PØ = PP + PØØ	01
	PM = PØ + FF	02

*Columns 77–80 must have numeric values in the range 0200 to 0299 listed in ascending order; column 76 must be blank.

Note to keypunch operator: only those lines containing penciled values should be keypunched.

Fig. 3—Preliminary Equations for Surveillance Aircraft System Cost Model Shown on Input Sheet C-1

Input Sheet C-2: Cost-Element Equations

Sheet C-2 is used to enter the cost-element equations defined for the cost categories used in a specific cost model. The values of the cost categories are calculated in turn by the computer program by summing the computed value of the component cost elements to the levels of the cost categories.

The cost categories for the Surveillance Aircraft System Cost Model as presented in Chap. 4 contain 30 cost-element equations. Each of these cost-element equations, as written in FORTRAN IV programming language, is shown on input Sheet C-2 in Fig. 4.

On the left of the equal sign the name of each cost element has been replaced by a FORTRAN array name that identifies the cost category to which each element belongs. The FORTRAN names are similar to the digit-level indicators used to identify the cost categories and their elements, as shown in Table 1. As can be seen from Fig. 4 the FORTRAN name "X" (fixed name) identifies a cost element in the category of "Research and Development." Similarly, "Y" (fixed name) identifies a cost element within the category of "Initial Investment," and "Z" (fixed name) within a category of "Annual Operating."

The second-, third-, and fourth-digit indicators identify the specific cost element.

For example the cost category "2.0 Initial Investment—2.1 Personnel—2.1.1 Training" includes the following elements:

2.1.1.1	New Pilots	= PPN × TPN
2.1.1.2	Transitional Pilots	= PPT × TPT
2.1.1.3	Officers, Other	= POO × TOO
2.1.1.4	Enlisted	= PE × TE

These same cost-element equations are translated into FORTRAN statements as follows:

```
Y (1, 1, 1) = PPN * TPN
Y (1, 1, 2) = PPT * TPT
Y (1, 1, 3) = PØØ * TØØ
Y (1, 1, 4) = PE * TE
```

The FORTRAN expressions on the right of the equal sign are similar in form to the mathematical equations devised for the Surveillance Aircraft System Cost Model. (Because the FORTRAN language uses periods for another purpose, the digit-level indicators are set off with commas in Input Sheet C-2.) With minor exceptions the mnemonic names used in the equations are used as FORTRAN variable names. In addition the FORTRAN arithmetic operators listed are relatively close to the mathematical operators normally used for hand computations:

+ = addition
− = subtraction
* = multiplication
/ = division

Input Sheet C-3: COMMON Data Sequence

Input Sheet C-3 lists the mnemonic names for the major data items used in the FORTRAN statements on Sheets C-1 and C-2. (The names included on

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

Name ______________________

Date ______________________

Page ______________________

SHEET C-2

COST ELEMENT EQUATIONS

Card No. / Equation (6–72)	Identification* (76–80)
X(1,1,1) = RDAC	0300
X(2,1,1) = RDS	01
Y(1,1,1) = PPN • TPN	02
Y(1,1,2) = PPT • TPT	03
Y(1,1,3) = PØØ • TØØ	04
Y(1,1,4) = PE • TE	05
Y(1,2,1) = (TVØ • PØ) • (TVE • PE)	06
Y(2,1,1) = FACI	07
Y(3,1,1) = ACT • CAC	08
Y(3,2,1) = SG • CSG	09
Y(3,3,1) = VEST(IQUIP, EQUIP)	10
Y(3,4,1) = PM • CØE	11
Y(4,1,1) = SP • ACT • CAC	12
Y(4,2,1) = (SM/12.0) • PØL • SA(2) • ACI	13
Y(4,3,1) = STØCKS(IQUIP, EQUIP, SA(1))	14
Z(1,1,1) = YRS • TPN • (PP • TØRP)	15
Z(1,1,2) = YRS • TØØ • (PØØ • TØRØ)	16
Z(1,1,3) = YRS • TE • (PE • TØRE)	17
(, ,) =	
(, ,) =	
(, ,) =	
	03

*Columns 77–80 must have numeric values in the range 0300 to 0399 listed in ascending order; column 76 must be blank.

Note to keypunch operator: only those lines containing penciled values should be keypunched.

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

Name __________

Date __________

Page __________

SHEET C-2

COST ELEMENT EQUATIONS

Card No. (6)	Equation (7–72)	Identification* (76–80)
	Z(1,2,1) = YRS • PR • PAR	18
	Z(1,2,2) = YRS • PNR • PANR	19
	Z(1,2,3) = YRS • PE • PAE	20
	Z(1,2,4) = YRS • PC • PAC	21
	Z(1,3,1) = YRS • (TVØ • (PP • TØRP + PØØ • TØRØ) + TVE • PE • TØRE)	22
	Z(2,1,1) = YRS • CAC • RNUP((ACI • SA(2)) • (RCAC/100000.0))	23
	Z(2,2,1) = RC(IQUIP, EQUIP, YRS)	24
	Z(3,1,1) = YRS • FACM	25
	Z(3,2,1) = YRS • ACI • CMFH • SA(2)	26
	Z(3,3,1) = YRS • PM • CMU	27
	Z(4,1,1) = YRS • ACI • PØL • SA(2)	28
	Z(5,1,1) = YRS • PM • CØ	29
	(, ,) =	
	(, ,) =	
	(, ,) =	
	(, ,) =	
	(, ,) =	
	(, ,) =	
	(, ,) =	
	(, ,) =	
	(, ,) =	
		03

*Columns 77–80 must have numeric values in the range 0330 to 0399 listed in ascending order; column 76 must be blank.

Note to keypunch operator: only those lines containing penciled values should be keypunched.

Fig. 4—Cost-Element Equations for Surveillance Aircraft System Cost Model Shown on Input Sheet C-2

this form do not include the mnemonics used for sensitivity assumptions, years of operation, or "other specified equipment." These are handled internally within the computer program.)

Sheet C-3 assigns the sequential order in which the major data items will be entered on Sheet A-1, "Major Data Inputs," described in a subsequent section. The listing of these names may be in any sequence that is convenient for collection and posting on Sheet A-1.

An example of the listing of data names on Sheet C-3 is provided in Fig. 5. For purposes of illustration the mnemonic names and sequential order of the listing are based on the data tabulation shown in App A.

Input Sheet B-1: Cost Category/Element Names

The cost-category and cost-element names to appear on the output listings for the ISOC Model are entered on Sheet B-1.

In the Surveillance Aircraft System Cost Model the mnemonic name for each cost category and element calculation was identified by a digit-level indicator (see Table 1), e.g.,

$$2.1.1.1 \quad \text{New Pilots} = PPN \times TPN$$

For computational purposes these four-digit-level indicators were slightly modified in the FORTRAN statements used in the ISOC Model, e.g.,

$$Y\,(1,\,1,\,1) = PPN * TPN,$$

where Y = investment cost category, and Y_2, Y_3, and Y_4 represent the second-, third-, and fourth-digit indicators for the particular cost element within that cost category.

On input Sheet B-1 the four-digit-level indicators, utilized as mnemonic names in the equations for the Surveillance Aircraft System Cost Model, associate the English name to appear on the output listing with the results of the calculations within the ISOC Model.

Figure 6 shows the entry on Sheet B-1 of the names and corresponding digit indicators for the cost categories and elements in the Surveillance Aircraft System Cost Model listed in Table 1. It should be noted that the arrangement of the names on this input sheet will determine the order of the listing on output format.

Input Sheet B-2: Selected Data for Printout

The cost analyst may select up to 10 data items to be printed out for each alternative costed. Input Sheet B-2 is used to list the specific input parameters that are desired for output for each alternative.

The data selected for printout for each alternative in the Surveillance Aircraft System Cost Model consisted of the following items:

New pilots
Transitional pilots
Total pilots
Other officers
Total officers

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

SHEET C-3

COMMON DATA SEQUENCE

Name ______________________

Date ______________________

Cont. No.	Data List — Data Names in Input Order—Separate by Commas (7–72)	Identification* (76–80)
6	7 … 72	76 … 80
0	CØMMØN PPN, PPT, CP, PR, PNR, PØØ, PØ, PE, PM, PC, TPN, TPT, TØØ,	0100
1	TE, TØKP, TØRØ, TØRE, PAR, PANR, PAE, PAC, TVØ, TVE, ACT, ACI, SG,	1
2	CAC, CSG, CØE, RCAC, SP, PØL, CMFH, CMU, CØ, SM, RDAC, RDS, FACI,	2
3	EACM	3
4		4
5		5
6		6
7		7
8		8
9		0109

*Columns 77–80 must have numeric values in the range 0100 to 0109 listed in ascending order; column 76 must be blank.

Note to data preparer: Data and values on sheet A-1 must be listed in exactly the same order from left to right as they appear in COMMON listing above.
Note to keypunch operator: only those lines containing penciled values should be keypunched.

Fig. 5—COMMON Data Sequence of Mnemonic Names for Major Data Items Included in Surveillance Aircraft System Cost Model-Shown on Input Sheet C-3

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

SHEET B-1

COST CATEGORY/ELEMENT NAMES
(UP TO 100)

Name ______________________

Date ______________________

Page ______________________

Cost Category (integers) 1–8	Description for Printout 9–56	Identification* 76–80
1....	RESEARCH AND DEVELØPMENT	2000
1.1...	AIRCRAFT	01
1.2...	SURVEILLANCE	02
2....	INITIAL INVESTMENT	03
.1...	PERSØNNEL	04
..1..	TRAINING	05
...1.	NEW PILØTS	06
...2.	TRANSITIØNAL PILØTS	07
...3.	ØFFICER - ØTHER	08
..1.4.	ENLISTED	09
.1.2..	TRAVEL	10
.2...	INSTALLATIØNS	11
.3...	EQUIPMENT	12
..1..	AIRCRAFT	13
..2..	GRØUND SUPPØRT	14
..3..	ØTHER SPECIFIED	15
.3.4..	ØRGANIZATIØNAL	16
.4...	INITIAL STØCKS	17
..1..	AIRCRAFT SPARES	18
..2..	AIRCRAFT PØL	19
2.4.3..	ØTHER SPECIFIED	20
3....	ANNUAL ØPERATING	21
.1...	PERSØNNEL	22
.1.1..	TRAINING	23
3.1.1.1.	PILØTS	2024

*Columns 77–80 must have numeric values in the range 2000 to 2999 listed in ascending order, column 76 must be blank

Note to keypunch operator only those lines containing penciled values should be keypunched.

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

Name ______________

Date ______________

Page ______________

SHEET B-1

COST CATEGORY/ELEMENT NAMES
(UP TO 100)

Cost Category (integers) 1–8	Description for Printout 9–56	Identification* 76–80
3 . . 1 . 2 .	ØFFICER - ØTHER	2025
. . 1 . 3 .	ENLISTED	26
. . 2 . .	PAY AND ALLØWANCES	27
. . . 1 . 1 .	ØFFICER RATED	28
. . . 2 .	ØFFICER NØN-RATED	29
. . . 3 .	ENLISTED	30
. . 2 . 4 .	CIVILIAN	31
. 1 . 3 . .	TRAVEL	32
. 2 . . .	EQUIPMENT	33
. 2 . 1 . .	AIRCRAFT ATTRITIØN	34
. 2 . 2 . .	ØTHER REPLACEMENT-CØNSUMPTIØN	35
. 3 . . .	MAINTENANCE	36
. . 1 . .	FACILITIES	37
. . 2 . .	AIRCRAFT	38
. 3 . 3 . .	ØTHER EQUIPMENT	39
. 4 . . .	PØL	40
3 . 5 . . .	SERVICES AND ØTHER	2041

*Columns 77–80 must have numeric values in the range 2000 to 2999 listed in ascending order; column 76 must be blank.

Note to keypunch operator: only those lines containing penciled values should be keypunched.

Fig. 6—Names and Digit Indicators of Cost Categories and Cost Elements for Surveillance Aircraft System Cost Model Shown on Input Sheet B-1

Enlisted personnel
Total military personnel
Peacetime attrition per 100,000 flying hours
Number of aircraft
Average unit aircraft cost

The items were entered on Sheet B-2 as shown in Fig. 7.

Input Sheet B-3: Other Specified Equipment Items

The cost data for up to 300 "other specified equipment" items are entered on Sheet B-3. In the example of the Surveillance Aircraft System Cost Model, "other specified equipment" represented the costs for all specified equipment other than aircraft and ground support. In other cost models, this same subroutine may include all specified equipment if desired. Residual equipment, i.e., "organizational," was handled on a dollar-per-man basis.

In the ISOC Model this information is placed in a library for use whenever a system or organization requires a specific set of data (a general description of the features of the library is provided in Chap. 3). A computer subprogram designed to simplify the calculations for "other specified equipment" is next described.

A sample of input data on Sheet B-3 is shown in Fig. 8 for the hypothetical surveillance-aircraft systems.

Subprograms for Other Specified Equipment

In the ISOC Model special subprograms have been devised to simplify the cost calculations for the "other specified equipment" cost elements. This permits the cost analyst to "call" data values from a library through the computer program rather than entering cost inputs, maintenance-float factors, replacement/consumption factors, and combat-consumption factors for each materiel item each time a system or organization is to be costed (see Chap. 3 for a general description of the materiel data library). The following example illustrates the use and calculation process of the subprogram.

Assume that it is desired to compute cost element "2.3.3 Initial Allowances Plus Maintenance Float for Other Specified Equipment."

The cost analyst would code the cost-element equation as follows on Sheet C-2 "Cost Element Equations" (Fig. 4)

Y (3, 3, 1) = VEST (IQUIP, EQUIP)

The analyst would then enter those equipment items that are common to more than one organization or system on Sheet B-3 "Other Specified Equipment Items." Assume further than the relevant data in the library for the five equipment items provided the following information:

Equipment code	Unit cost, dollars	Maintenance float
A	1000	0.10
B	1500	0.07
C	2000	0.05
D	3000	0.10
E	4000	0.05

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

SHEET B-2

SELECTED DATA FOR PRINTOUT
(UP TO 10)

Name ______________________

Date ______________________

Data Code (1–6)	Description (7–72)	Identification* (76–80)
PPN	NEW PILØTS	3000
PPT	TRANSITIØNAL PILØTS	1
PP	TØTAL PILØTS	2
PØØ	ØTHER ØFFICERS	3
PØ	TØTAL ØFFICERS	4
PE	ENLISTED PERSØNNEL	5
PM	TØTAL MILITARY PERSØNNEL	6
RCAC	PEACETIME ATTRITIØN PER 100000 FLYING HØURS	7
ACI	NUMBER ØF AIRCRAFT	8
CAC	AVERAGE UNIT AIRCRAFT CØST	3009

*Column 76 must be blank.

Note to keypunch operator: only those lines containing penciled values should be keypunched.

Fig. 7—Items Selected for Printout in Surveillance Aircraft System Cost Model Shown on Input Sheet B-2

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

Name ______________________

SHEET B-3

Date ______________________

OTHER SPECIFIED EQUIPMENT ITEMS
(UP TO 300 ITEMS)

Equipment Code (1–6)	Name (7–36)	Cost* (37–45)	Maintenance Float (46–54)	Replacement Consumption (55–63)	Combat Consumption (64–72)	Identification** (76–80)
EXPL00	GUN MACHINE 7.62 MM EXAMPLE	500	.10	.020	.10	4000
01	GUN MACHINE CAL .50	500	.10	.020	.05	01
02	RIFLE 7.62 MM	100	.10	.050	.05	02
03	TRUCK 3/4 TØN ABT	3000	.10	.060	.07	03
04	TRUCK 2 1/2 TØN ABT	5000	.10	.050	.01	04
05	TRUCK FUEL SERV 5000GAL	15000	.10	.020	.03	05
06	TRUCK UTILITY 1/4 TØN	2000	.05	.050	.06	06
07	RADIØ SET AN/VRC-XX	5000	.05	.030	.02	07
08	RADIØ SET AN/PRC-XX	5000	.05	.030	.01	08
09	RADAR SET AN/MPQ-XX	50000	.02	.030	.01	09
10	GENERATØR SET	1000	.10	.050	.01	10
11	DARKRØØM PHØTØGRAPHIC	20000	.	.020	.	11
12	TEST SET RECEIVING	5000	.05	.	.	12
EXPL13	TEST SET RADAR EXAMPLE	5000	.05	.	.	013

*Post decimal if not integer.
**Columns 77–80 must have numeric values in the range 4000 to 4299 listed in ascending order; column 76 must be blank.

Note to keypunch operator: only those lines containing penciled values should be keypunched.

Fig. 8—Selected Items of Other Specified Equipment for Surveillance Aircraft Systems Shown on Input Sheet B-3

This information, when entered on Sheet B-3, will then be available for future calculations as is described in the previous section.

If four of these equipment items in the library are to be costed, the analyst would enter the following equipment codes and their initial allowances on input Sheet A-2 "Initial Allowances of Other Specified Equipment":

Equipment code	Initial allowances
A	2
C	5
D	1
E	7

For the items selected for the particular configuration the calculations would then be carried out by the VEST subprogram, using the cost-element equation shown on Table 1 for Initial Investment of Other Specified Equipment:

$$\sum_{i=1}^{N} IA_i \,(1 + MF_i)\, C_i$$

where i = equipment item
N = total number of other specified equipment items in system or organization
IA_i = initial allowance of item i
C_i = cost of item i
MF_i = maintenance-float factor of item i

The results of the calculations through the computer subprogram would be as follows:

Equipment code	IA_i		MF_i		Cost/unit, dollars		Items C_i		Cost/C_i, dollars
A	2	x	(1 + .10)	=	2.20	x	1000	=	2,200
C	5	x	(1 + .05)	=	5.25	x	2000	=	10,500
D	1	x	(1 + .10)	=	1.10	x	3000	=	3,300
E	7	x	(1 + .05)	=	7.35	x	4000	=	29,400
Total									45,400

The equations for the other subprograms available in the ISOC Model are described as follows:

(a) Initial stocks for "other specified equipment"

$$\sum_{i=1}^{N} IA_i \times CC_i \times LOG \times C_i$$

where CC_i is the combat-consumption factor for item i and LOG is the number of months of combat stockage. The other symbols, IA_i and C_i, are defined above.

(b) Initial allowances plus maintenance float plus stocks for "other specified equipment"

$$\sum_{i=1}^{N} [IA_i (1+MF_i) + (IA_i \times CC_i \times LOG)] C_i$$

where all symbols are defined in the previous equations.

(c) Annual operating costs for "other replacement/consumption"

$$\sum_{i=1}^{N} [(IA_i \times RC_i) C_i] \text{ YRS}$$

where RC_i is the replacement/consumption factor for equipment item i, YRS is years of operation, and the other symbols as defined above.

Input Sheet B-4: General-Sensitivity Assumptions

Input Sheet B-4 (Fig. 9) is used to enter data relating to sensitivity assumptions. In addition a scale factor is entered on the sheet for selecting the scale of the cost output (thousands, tens of thousands, hundreds of thousands, millions).

The sensitivity assumptions entered on Sheet B-4 relate to all organizations or systems to be costed. Once these data have been entered in an ISOC Model configuration, the factors automatically will be used each time a system or organization is costed. Usually these sensitivity assumptions will represent activity factors as compared with cost or specification factors (see description of sensitivity analysis in previous chapter).

It is possible to select up to five different years of operations and a maximum of five sensitivity assumptions with a maximum of five different factors. Caution must be used in choosing the number of assumptions to be analyzed and the number of values considered for each. Not only will the data on this input sheet be recycled each time an organization or system is introduced into the ISOC Model, but also there is a potentiality for automatically calculating the costs of 15,625 alternatives for one system or organization ($5^6 = 15,625$). Obviously it is necessary that the cost analyst take care in selecting the number of sensitivity assumptions and the number of factors for each assumption. At the present time no decision criteria have been programmed for limiting the output of the ISOC Model.

The following sensitivity assumptions selected for the Surveillance Aircraft System Cost Model are entered on Sheet B-4,

(a) Years of operations: 3, 5, 7, 9, and 11.

(b) Annual peacetime flying hours per aircraft: 240, 360, and 480.

(c) Combat-consumption-stockage policy (LOG GUIDANCE): 2 months and 6 months.

COSTING OF ALTERNATIVE SYSTEMS OR ORGANIZATIONS

The preceding section describes the adaptation of the ISOC Model to the Surveillance Aircraft System Cost Model. The ISOC Model in this configuration is capable of calculating the relative costs of any number of surveillance aircraft systems. All the necessary inputs to operate the ISOC Model have

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

SHEET B-4

GENERAL SENSITIVITY ASSUMPTIONS

Name ______________

Date ______________

Scale Index – Integer { 0 – Thousands; 1 – Tens of Thousands; 2 – Hundreds of Thousands; 3 – Millions }

	1	Identification* 76–80
Scale Factor for Output	3	1 0 0 0

Number of Years of Operation—Integers Only

	1–6	7–12	13–18	19–24	25–30	Identification 76–80
Years of Operation (up to 5 choices) YRS	3	5	7	9	11	1 0 0 1

Parameters—Post Decimal if not Integer

Sensitivity Parameters (up to 5 choices each)	Description 1–12	13–21	22–30	31–39	40–48	49–57	Identification 76–80
SA(1)	LOG GUIDANCE	2	6				1 0 0 2
SA(2)	FLYING HOURS	240	360	480			3
SA(3)							4
SA(4)							5
SA(5)							1 0 0 6

*Column 76 must be blank.

Note to keypunch operator: only those lines containing penciled values should be keypunched.

Fig. 9—Sensitivity Assumptions Selected for the Surveillance Aircraft System Cost Model Shown on Input Sheet B-4

been presented except the actual cost data required to calculate the costs of an alternative.

These data values for costing alternatives are entered on three specially designed input sheets: Sheet A-1, "Major Data Inputs"; Sheet A-2, "Initial Allowances of Other Specified Equipment"; and Sheet A-3, "Major Data-Change Sheet."

For illustrative purposes in using the ISOC Model, 240 alternative configurations for the two hypothetical surveillance aircraft systems are assumed to be required for cost-sensitivity analysis. (In reality, a cost analyst usually would not require the cost estimates for all these 240 alternatives.) Sensitivity assumptions selected are:

(a) Years of peacetime operating: 3, 5, 7, 9, and 11.

(b) Annual peacetime flying-hour program: 240, 360, and 480.

(c) Combat-consumption-stockage policy: 2 months and 6 months.

(d) Aircraft cost estimates: upper and lower estimate for each aircraft.

(e) Peacetime attrition per 100,000 flying hours: upper and lower estimate for each aircraft.

For costing these 240 alternatives only 10 input sheets would be required:

Surveillance-aircraft system A:

<u>One</u> input Sheet A-1, "Major Data Inputs," containing lower-cost-estimate value and lower-attrition-estimate value for aircraft A.

<u>One</u> input Sheet A-2, "Initial Allowances of Other Specified Equipment."

<u>Three</u> input Sheets A-3, "Major Data-Change Sheets," for each of the following data changes:

(a) Lower-cost-estimate value and upper-attrition-estimate value for aircraft A.

(b) Upper-cost-estimate value and lower-attrition-estimate value for aircraft A.

(c) Upper-cost estimate and upper-attrition value for aircraft A.

Surveillance-aircraft system B:

<u>One</u> input Sheet A-1, "Major Data Inputs," containing lower-cost-estimate value and lower-attrition-estimate value for aircraft B.

<u>One</u> input Sheet A-2, "Initial Allowances of Other Specified Equipment."

<u>Three</u> input Sheets A-3, "Major Data-Change Sheets," for each of the following data changes:

(a) Lower-cost-estimate value and upper-attrition value for aircraft B.

(b) Upper-cost-estimate value and lower-attrition-estimate value for aircraft B.

(c) Upper-cost-estimate value and upper-attrition value for aircraft B.

Input procedures and data requirements for these input sheets are described in the following sections.

Input Sheet A-1: Major Data Inputs

This input sheet is used to enter the data values associated with each variable data name used in the cost-model equations. A number of mnemonic names used in the cost-element equations are fixed names; e.g., years of operation YRS and the sensitivity assumptions SA(1) to SA(5) are predetermined.

These names or their data values are not listed on input Sheet A-1. This input sheet must be used for each organization or system to be costed.

In adapting the ISOC Model to the Surveillance Aircraft System Cost Model the analyst would list the variable names used and then arrange these mnemonic names on a master of input Sheet A-1 in an order that would be convenient for collection and posting. Duplicates of this master could then be used to enter the actual data values required in calculating the costs for different surveillance systems.

The information entered on input Sheet A-1 lists an alternative identifier, a title card, a maximum of six lines of comments, and the major data values.

Figures 10 and 11 show the input data for aircraft system A and aircraft system B, respectively. These data values posted on these two input sheets were extracted from a worksheet given in App A.

The input values for the total number of pilots (PP), total number of officers (PO), and total number of military personnel (PM) were not entered. These figures will be calculated in the ISOC Model according to procedures described in the section "Input Sheet C-1: Preliminary Equations." The equations are entered on input Sheet C-1, as shown on Fig. 3.

Input Sheet A-2: Initial Allowances of Other Specified Equipment

The input sheet may be used to enter the initial allowances for those equipment items for which cost factors are entered in the ISOC Model library (for a discussion on using this feature of the ISOC Model, see the previous section "Subprograms for Other Specified Equipment").

The initial allowances of "other specified equipment" for the two surveillance-aircraft systems (presented in App A) are entered on input Sheet A-2 as illustrated in Figs. 12 and 13. It should be noted that the descriptive name for each item is for the cost analyst's use and is not to be keypunched.

Input Sheet A-3: Major Data-Change Sheet

This input sheet may be used to change the configuration of the major data values listed on input Sheet A-1 (Figs. 10 and 11). Once the data values have been changed the ISOC Model will recalculate the total cost for the system or organization. With the use of input Sheet A-3, any number of sets of changes can be made during one computer run.

The "Major Data-Change Sheet" may be used to test the sensitivity of the major assumptions peculiar to a given system. For example the sensitivity of the cost estimate for a future aircraft could be tested using this input sheet. This is in contrast to those sensitivity assumptions entered on input Sheet B-4 (Fig. 9), for which activity factors will be used in all systems costed by the ISOC Model.

An example of using this input sheet is shown in Figs. 14 and 15 for aircraft systems A and B, respectively. The input sheets were used to enter the upper-attrition estimates for the two aircraft.

OUTPUT FORMAT FOR THE ISOC MODEL

This chapter has presented an illustration of the input data required by the ISOC Model to calculate the relative costs of two hypothetical surveillance

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

SHEET A-1

Name ______________

Date ______________

MAJOR DATA INPUTS
(EXCLUDING OTHER SPECIFIED EQUIPMENT)

Alternative (alphameric) 1–4	Descriptive Title 5–75	Identification 76–80
EX 1	SURVEILLANCE - AIRCRAFT A	A5000

Comments

1–75	76–80
LOWER CØST ESTIMATE FØR AIRCRAFT USED	A5001
LOWER PEACETIME ATTRITIØN FACTØR PER 100,000 FLYING HØURS USED	2
ACFT DESIGN CHARACTERISTICS - TURBØPRØP, .6 MACH, 8500 EMPTY WEIGHT	3
THE CØST FACTØRS PRESENTED BELØW ARE FØR ILLUSTRATIVE PURPØSES ØNLY	4
THE FACTØRS USED IN THE EXAMPLE ARE FICTITIØUS	A 5
	5006

See Common (Sheet C-3) for ordering of data

Data Code 1–6	Value* 7–15	Data Code 16–21	Value* 22–30	Data Code 31–36	Value* 37–45	Data Code 46–51	Value* 52–60	Data Code 61–66	Value* 67–75	Identification** 76–80
PPN	160	PPT	155	PP		PR	346	PNR	246	A5100
PØØ	277	PØ		PE	2000	PM		PC	0	1
TPN	50000	TPT	2000	TØØ	4000	TE	2000	TØRP	.10	2
TØRØ	.20	TØRE	.15	PAR	15000	PANR	10000	PAE	5000	3
PAC	0	TVØ	3000	TVE	1500	ACT	120	ACT	100	4
SG	5	CAC	700000	CSG	800000	CØE	1.000	RCAC	8	5
SP	1.5	PØL	50	CMEN	1.00	CMU	100	CØ	400	6
SM	1	RDAC	25000000	RDS	75000000	FACI	10000000	FACM	1500000	A 07

*Post decimal if not integer

**Columns 77–80 must have numeric values in the range 5100 to 5199 listed in ascending order, column 76 must have an alphabetic character designating the alternative

Note to keypunch operator: only those lines containing penciled values should be keypunched.

Fig. 10—Major Data Inputs for Surveillance Aircraft System A Shown on Input Sheet A-1

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

SHEET A-1

MAJOR DATA INPUTS
(EXCLUDING OTHER SPECIFIED EQUIPMENT)

Name ______________
Date ______________

Alternative (alphameric) 1–4	Descriptive Title 5–75	Identification 76–80
EX 5	SURVEILLANCE SYSTEM — AIRCRAFT B	B5000

Comments

Comments 1–75	Identification 76–80
LOWER COST ESTIMATE FOR AIRCRAFT USED	B5001
LOWER PEACETIME ATTRITION FACTOR PER 100,000 FLYING HOURS USED	T 2
ACFT DESIGN CHARACTERISTICS-SUBSONIC JET .9 MACH 10000 EMPTY WEIGHT	3
THE COSTS PRESENTED BELOW ARE FOR ILLUSTRATIVE PURPOSES ONLY	4
THE FACTORS USED IN THE EXAMPLE ARE FICTITIOUS	B 5
	5006

See Common (Sheet C-3) for ordering of data

Data Code 1–6	Value* 7–15	Data Code 16–21	Value* 22–30	Data Code 31–36	Value* 37–45	Data Code 46–51	Value* 52–60	Data Code 61–66	Value* 67–75	Identification** 76–80
PPN	75	PPT	60	PP		FR	179	PMR	1.01	B5100
PØØ	55	PØ		PE	800	PM		PC	250	T 1
TPN	120000	TPT	10000	TØØ	4000	TE	2000	TØRP	.15	2
TØRØ	.18	TØRE	.20	PAR	16000	PANR	9500	PAE	5000	3
PAØ	2000	TVØ	3000	TVE	1500	ACT	55	AET	45	4
SG	5	CAC	1500000	CSG	700000	CAE	800	RCAU	.15	5
SP	.30	PØL	100	CMEH	250	CAU	1000	CØ	300	6
SM	2	RDAC	30000000	RDS	0	EAAT	5000000	EACM	2500000	B 07

*Post decimal if not integer

**Columns 77–80 must have numeric values in the range 5100 to 5199 listed in ascending order, column 76 must have an alphabetic character designating [illegible] alternative.

Note to keypunch operator: only those lines containing pencil[illegible] es should be keypunched.

Fig. 11—Major Data Inputs for Surveillance Aircraft System B Shown on Input Sheet A-1

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

SHEET A-2

Name ______________________

Date ______________________

INITIAL ALLOWANCES OF OTHER SPECIFIED EQUIPMENT
(UP TO 300)

Equipment Name	Equipment Codes (1–6)	Initial Allowance (7–15)	Identification* (76–80)
Machine gun 7.62 mm	EXPL00	50	A5201
Rifle 7.62 mm	02	1800	02
2½ ton truck	04	100	03
Fuel service truck 5000 gal.	05	25	04
Utility truck ¼ ton	06	200	05
Radio set AN/VRC-XX	07	100	06
Radar set AN/MPQ-XX	09	10	07
Generator set	10	10	08
Darkroom photographic	11	10	09
Radar test set	EXPL13	5	A 210

*Columns 77–80 must have numeric values in the range 5200 to 5899 listed in ascending order, column 76 must have an alphabetic character designating the alternative.

Note to keypunch operator: only those lines containing penciled values should be key punched.

Fig. 12—Initial Allowances of Other Specified Equipment for Surveillance Aircraft System A Shown on Input Sheet A-2

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

Name ____________________

Date ____________________

SHEET A-2

INITIAL ALLOWANCES OF OTHER SPECIFIED EQUIPMENT
(UP TO 300)

Equipment Name	Equipment Codes (1–6)	Initial Allowance (7–15)	Identification* (76–80)
Machine gun 7.62 mm	EXPL00	100	B5201
Machine gun .50 cal	" 01	10	" 02
Rifle 7.62 mm	" 02	1000	" 03
3/4 ton truck	" 03	90	" 04
2 1/2 ton truck	" 04	120	" 05
Fuel serv truck 5000 gal	" 05	40	" 06
Utility truck 1/4 ton	" 06	175	" 07
Radio set AN/PRC-XX	" 08	70	" 08
Radar set AN/MPQ-XX	" 09	15	" 09
Generator set	" 10	12	" 10
Darkroom photographic	" 11	10	" 11
Radar test set	EXPL13	6	B212

*Columns 77–80 must have numeric values in the range 5200 to 5999 listed in ascending order; column 76 must have an alphabetic character designating the alternative.

Note to keypunch operator: only those lines containing penciled values should be key punched.

Fig. 13—Initial Allowances of Other Specified Equipment for Surveillance Aircraft System B Shown on Input Sheet A-2

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

SHEET A-3

MAJOR DATA CHANGE SHEET

Name ____________________

Date ____________________

Alternative (alphameric) 1–4	Descriptive Title 5–75	Identification 76–80
EX 4	SURVEILLANCE SYSTEM - AIRCRAFT A	A6000

Comments

1–72	76–80
UPPER CAST ESTIMATE FØR AIRCRAFT USED	A6001
UPPER PEACETIME ATTRITIØN FACTØR PER 100,000 FLYING HØURS USED	2
ACFT DESIGN CHARACTERISTICS - TURBØPRØP .6 MACH 8500 EMPTY WEIGHT	3
THE CØST FACTØRS PRESENTED BELØW ARE FØR ILLUSTRATIVE PURPØSES ØNLY	4
I.E FACTØRS USED IN THE EXAMPLE PRESENTED BELØW ARE FICTITIØUS	A 5
	06

Data Changes

Data Code 1–6	Value* 7–15	Data Code 16–21	Value* 22–30	Data Code 31–36	Value* 37–45	Data Code 46–51	Value* 52–60	Data Code 61–66	Value* 67–75	76–80**
RCAC	12									A6010
										11
										12
										13
										14
										15
										16
										17
										18
										19
										20

More or End*** 1–4	76–80
MØRE	A9999

*Post decimal point if not integer

**Column 76 must have an alphabetic character designating the alternative. Columns 77 and 78 will be the same for all cards on one page but will be increased by one for each successive set of changes for a given alternative. The numbers in columns 77–78 must be in the range 60–99

***Only if this is last set of data changes for alternative.

Note to keypunch operator: only those lines containing penciled values should be keypunched.

Fig. 14—Major Data Changes for Surveillance Aircraft System A Shown on Input Sheet A-3

INDIVIDUAL SYSTEM/ORGANIZATION COST MODEL

SHEET A-3

MAJOR DATA CHANGE SHEET

Name ______________

Date ______________

Alternative (alphameric) 1–4	Descriptive Title 5–75	Identification** 76–80
EX 8	SURVEILLANCE SYSTEM - AIRCRAFT B	B6000

Comments

Comments 1–72	76–80
UPPER COST ESTIMATE FOR AIRCRAFT	B6001
UPPER PEACETIME ATTRITION FACTOR PER 100,000 FLYING HOURS USED	2
ACFT DESIGN CHARACTERISTICS - SUBSONIC JET .9 MACH 10000 EMPTY WEIGHT	3
THE COST FACTORS PRESENTED BELOW ARE FOR ILLUSTRATIVE PURPOSES ONLY	4
THE FACTORS USED IN THE EXAMPLE PRESENTED BELOW ARE FICTITIOUS	B 5
	06

Data Changes

Data Code 1–6	Value* 7–15	Data Code 16–21	Value* 22–30	Data Code 31–36	Value* 37–45	Data Code 46–51	Value* 52–60	Data Code 61–66	Value* 67–75	76–80
RCAC	25									B6C10
										11
										12
										13
										14
										15
										16
										17
										18
										19
										20

More or End*** 1–4		76–80
END		B9999

*Post decimal point if not integer.
**Column 76 must have an alphabetic character designating the alternative. Columns 77 and 78 will be the same for all cards on one page but will be increased by one for each successive set of changes for a given alternative. The numbers in columns 77–78 must be in the range 60–99.
***Only if this is last set of data changes for alternative.

Note to keypunch operator: only those lines containing penciled values should be keypunched.

Fig. 15—Major Data Changes for Surveillance Aircraft System B Shown on Input Sheet A-3

INPUT CATA, ALTERNATIVE EX 5 SURVEILLANCE SYSTEM - AIRCRAFT B

PPN	75.CCCC
PPT	6C.CCCC
PP	-C.
PR	179.CCCC
PNR	1C1.CCCC
PCC	55.CCCC
PC	-C.
PE	8CC.COCC
PM	-C.
PC	25C.COCC
TPN	12CCCC.00CC
TPT	1CCCC.OCCC
TCC	4COC.CCCC
TE	2CCC.CCCC
TCRP	C.15CC
TCRC	C.18CC
TCRE	C.2CCC
PAR	16CCC.CCCC
PANR	55CC.CCCC
PAE	5CCC.CCCC
PAC	2CCC.CCCC
TVC	3CCC.CCCC
TVE	15CC.CCCC

ACT	55.CCCC
ACT	45.CCCC
SG	3.CCCC
CAC	15CCCCC.COCC
CSG	7CCCCC.COCC
CCE	9CC.COCC
RCAC	15.COCC
SP	C.30CC
PCL	1CC.CCCC
CMFH	25C.CCCC
CMU	10C.COCC
CC	3C0.00CC
SM	2.00CC
RCAC	30CCCCCC.00CC
RDS	C.
FACI	5CCCCCC.00CC
FACM	25CCCCC.CCCC

INITIAL ALLCWANCE OF OTHER SPECIFIED EQUIPMENT

12 EQUIPMENT ITEMS SPECIFIED

EXPL00	10C.
EXPL01	1C.
EXPLC2	10CC.
EXPLC3	9C.
EXPL04	12C.
EXPL05	4C.
EXPLC6	175.
EXPL08	7C.
EXPL09	15.
EXPL1C	12.
EXPL11	1C.
EXPL13	6.

Fig. 16—Sample Output Format of the ISOC Model for Surveillance Aircraft System B

INCIVICUAL SYSTEM/CRGANIZATION COST MCCEL

SURVEILLANCE SYSTEM - AIRCRAFT B ALTERNATIVE EX 6
LOWER COST ESTIMATE FCR AIRCRAFT USED
UPPER PEACETIME ATTRITICN FACTCR PER 100,0CO FLYING HOURS USED
ACFT DESIGN CHARACTERISTICS - SUBSCNIC JET .9 MACH 10000 EMPTY WEIGHT
THE COST FACTCRS PRESENTED BELCW ARE FOR ILLUSTRATIVE PURPOSES ONLY
THE FACTORS USEC IN THE EXAMPLE PRESENTED BELOW ARE FICTIOUS

COST CATEGORIFS	DOLLARS IN MILLIONS			
RESEARCH AND DEVELCPMENT				
AIRCRAFT		-----	30.00	
SURVEILLANCE		-----	0.	
TOTAL RESEARCH AND DEVELCPMENT			-----	30.00
INITIAL INVESTMENT				
PERSONNEL				
TRAINING				
NEW PILCTS	9.00			
TRANSITIONAL PILCTS	0.60			
CFFICER-OTHER	0.22			
ENLISTED	1.60			
	-----	11.42		
TRAVEL	-----	1.77		
		-----	13.19	
INSTALLATICNS		-----	5.00	
EQUIPMENT				
AIRCRAFT	-----	82.50		
GROUND SUPPORT	-----	2.10		
OTHER SPECIFIEC	-----	3.65		
ORGANIZATICNAL	-----	0.79		
		-----	89.04	
INITIAL STOCKS				
AIRCRAFT SPARES	-----	24.75		
AIRCRAFT PCL	-----	0.27		
OTHER SPECIFIEC	-----	0.44		
		-----	25.46	
TOTAL INITIAL INVESTMENT			-----	132.69

COST CATEGORIES	DOLLARS IN MILLIONS			
ANNUAL OPERATING				
PERSONNEL				
TRAINING				
PILOTS	12.15			
OFFICER-OTHER	0.20			
ENLISTED	1.60			
	-----	13.95		
PAY AND ALLOWANCES				
OFFICER RATED	14.32			
OFFICER NON-RATED	4.80			
ENLISTED	20.00			
CIVILIAN	2.50			
	-----	41.62		
TRAVEL				
	-----	1.65		
		-----	57.22	
EQUIPMENT				
AIRCRAFT ATTRITION				
	-----	37.50		
OTHER REPLACEMENT-CONSUMPTION				
	-----	0.62		
		-----	38.12	
MAINTENANCE				
FACILITIES				
	-----	12.50		
AIRCRAFT				
	-----	20.25		
OTHER EQUIPMENT				
	-----	0.49		
		-----	33.24	
POL				
		-----	8.10	
SERVICES AND OTHER				
		-----	1.48	
TOTAL ANNUAL OPERATING			-----	138.17
TOTAL RESEARCH AND DEVELOPMENT, INITIAL INVESTMENT, ANNUAL OPERATING				300.86

Fig. 16 (continued)

SENSITIVITY PARAMETERS

YEARS CF OPERATION	5
LCG GLICANCE	6.00
FLYING HOURS	360.00

SELECTED DATA VALUES

NEW PILCTS	75.00
TRANSITICNAL PILOTS	60.00
TCTAL PILOTS	135.00
CTHER CFFICERS	55.00
TCTAL CFFICERS	190.00
ENLISTED PERSCNNEL	800.00
TOTAL MILITARY PERSONNEL	990.00
PEACETIME ATTRITICN PER 1CCCOC FLYING HOURS	25.00
NUMBER CF AIRCRAFT	45.00
AVERAGE UNIT AIRCRAFT COST	1500000.00

Fig. 16 (continued)

aircraft systems. It would be impractical to present all the output generated by the ISOC Model for the 240 alternatives that could have been costed. However, an example of one alternative costed for aircraft system B is illustrated in Fig. 16. In the example the following assumptions were tested for sensitivity:

Lower-aircraft cost estimate.
Upper-peacetime attrition estimate.
Years of peacetime operation: 5.
Annual peacetime flying hours: 360.
Months of combat stockage (LOG GUIDANCE): 6.

SUMMARY OF PROCEDURES FOR USING THE ISOC MODEL

The major steps required by a cost analyst to operate the ISOC Model may be summarized as follows: (a) determination of what is to be costed in terms that are capable of being costed, (b) selection of those major assumptions that should be tested for sensitivity, (c) formulation and design of the specific individual system or organization cost model, (d) preparation of the input data required to adapt the ISOC Model to a specific individual system or organization cost model, and (e) preparation of the input data required to cost the alternative systems or organizations.

When the above input data are placed in the computer program the ISOC Model is operational.

Appendix A

DATA VALUES FOR TWO HYPOTHETICAL AIRCRAFT SYSTEMS

Tables

This appendix contains the input data that were used for illustrative purposes in describing the input sheets for the ISOC Model in Chap. 5. It should be emphasized that the data values entered on these tables for the two hypothetical surveillance-aircraft systems are fictitious. Furthermore the items selected for entry on the tables are intended as examples only of the types of information that may be required in costing a system or organization. In an actual costing study the form of the cost categories, equations, and other data inputs would be determined by the nature of the specific costing problem and the cost information available to the analyst.

Three tables listing the input data for the Surveillance Aircraft System Cost Model are included in the appendix: Table A1, "Input-Data Worksheets"; Table A2, "Other Specified Equipment Items"; and Table A3, "Initial Allowances of Other Specified Equipment."

The worksheets in Tables A1 and A2 are also examples of the formats that are currently in use for convenient collection of input data. The inputs entered on the forms will of course vary with the requirements of the individual costing study to which the ISOC Model is applied.

Reference is made by footnotes in the tables to the input sheets on which the data items and values are entered.

TABLE A1

Surveillance Aircraft System Cost Model—Input Data Worksheet

Date

Input name	Code[a]	Aircraft Sys A [b]	Aircraft Sys B [c]		
		Input data			
Number of New Pilots	PPN	160	75		
Number of Transitional Pilots	PPT	155	60		
Total Number of Pilots	PP	315	135		
Number of Rated Officers	PR	346	179		
Number of Non Rated Officers	PNR	246	101		
Number of Other Officers	POO	277	55		
Total Number of Officers	PO	592	280		
Total Number of Enlisted	PE	2,000	800		
Total Number of Military Personnel	PM	2,592	1,080		
Total Number of Civilian Personnel	PC	0	250		
Initial Training Cost—New Pilot	TPN	$ 50,000	$ 120,000		
Initial Training Cost—Transitional Pilot	TPT	$ 2,000	$ 10,000		
Initial Training Cost—Other Officer	TOO	$ 4,000	$ 4,000		
Initial Training Cost—Enlisted	TE	$ 2,000	$ 2,000		
Turnover Ratio—Pilot	TORP	0.10	0.15		

[a]See Sheet C-3, Fig. 5.
[b]See Sheet A-1, Fig. 10.
[c]See Sheet A-1, Fig. 11.

TABLE A1 (continued)

Input name	Code	Aircraft Sys A	Aircraft Sys B	Date
		Input data		
Turnover Ratio—Other Officer	TORO	0.20	0.18	
Turnover Ratio—Enlisted	TORE	0.15	0.20	
Pay & Allowances—Rated Officer	PAR	$ 15,000	$ 16,000	
Pay & Allowances—Non Rated Officer	PANR	$ 10,000	$ 9,500	
Pay & Allowances—Enlisted	PAE	$ 5,000	$ 5,000	
Pay & Allowances—Civilian	PAC	0	$ 2,000	
Travel Cost—Officer	TVO	$ 3,000	$ 3,000	
Travel Cost—Enlisted	TVE	$ 1,500	$ 1,500	
Initial Allowance—Aircraft (I.A.&MF)	ACT	120	55	
Initial Allowance—Aircraft (I.A.)	ACI	100	45	
Initial Allowance—Sensor Ground	SG	5	3	
Average Cost Per Aircraft	CAC	$700,000–$800,000	$1,500,000–$1,800,000	
Average Cost Per Sensor Ground	CSG	$ 800,000	$ 700,000	
Cost—Organizational Equip $ Per PM	COE	$ 1,000	$ 800	
Replacement/Consumption—Aircraft	RCAC	8/12 [a]	15/25 [b]	
Initial Spares Factor—Aircraft	SP	0.15	0.30	

[a]See Sheet A-3, Fig. 14.
[b]See Sheet A-3, Fig. 15.

TABLE A1 (continued)

Input name	Code	Aircraft Sys A	Aircraft Sys B	Date
		Input data		
POL—Cost Per FH	POL	$ 50	$ 100	
Maintenance—Cost Per FH	CMFH	$ 100	$ 250	
Maintenance—Cost Per PM	CMU	$ 100	$ 100	
Services & Other—Cost Per PM	CO	$ 400	$ 300	
Months of Stockage	SM	1	2	
<u>Thruputs</u>				
Aircraft—Airborne & Ground	RDAC	$ 25,000,000	$ 30,000,000	
Surveillance—Airborne & Ground	RDS	$ 75,000,000	0	
Initial Installations	FACI	$ 10,000,000	$ 5,000,000	
Maintenance of Facilities	FACM	$ 1,500,000	$ 2,500,000	

<u>Sensitivity Assumptions</u>[a]

Years of peacetime operating: 3, 5, 7, 9, and 11.

Peacetime flying hours per aircraft: 240, 360, and 480.

Combat-consumption stockage policy: 2 months and 6 months.

[a]See Sheet B-4, Fig. 9.

TABLE A2

Surveillance Aircraft System Cost Model—Other Specified Equipment Items[a]

Equipment name (code IA)	Cost (code C)	Maintenance float factor (code MF)	Replacement consumption factor (code RC)	Combat consumption factor (code CC)
Gun, Machine, 7.62 mm	$ 500	0.10	0.02	0.10
Gun, Machine, cal .50	500	0.10	0.02	0.05
Rifle, 7.62 mm	100	0.10	0.05	0.05
Truck, ¾ ton, ABT	3,000	0.10	0.06	0.02
Truck, 2½ ton, ABT	5,000	0.10	0.05	0.01
Truck, Fuel Service, 5000 gal	15,000	0.10	0.02	0.03
Truck, Utility, ¼ ton	2,000	0.05	0.05	0.06
Radio Set, AN/VRC-XX	5,000	0.05	0.03	0.02
Radio Set, AN/PRC-XX	5,000	0.05	0.03	0.01
Radar Set, AN/MPQ-XX	50,000	0.02	0.03	0.01
Generator Set	10,000	0.10	0.05	0.01
Darkroom, Photographic	20,000	—	0.02	—
Test Set, Receiving	5,000	0.05	—	—
Test Set, Radar	5,000	0.05	—	—

[a]See Sheet B-3, Fig. 8.

TABLE A3

Surveillance Aircraft System Cost Model—Initial Allowances of Other Specified Equipment

Equipment name	Aircraft System A[a]	Aircraft System B[b]
	Initial allowances	
Gun, Machine, 7.62 mm	50	100
Gun, Machine, cal .50	—	10
Rifle, 7.62 mm	1800	1000
Truck, ¾ ton, ABT	—	90
Truck, 2½ ton, ABT	100	120
Truck, Fuel Service, 5000 gal	25	40
Truck, Utility, ¼ ton	200	175
Radio Set, AN/PRC-XX	—	70
Radio Set, AN/VRC-XX	100	—
Radar Set, AN/MPQ-XX	10	15
Generator Set	10	12
Darkroom, Photographic	10	10
Test Set, Receiving	—	—
Test Set, Radar	5	6

[a]See Sheet A-2, Fig. 12.
[b]See Sheet A-2, Fig. 13.